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NEW HARDWARE FOR TETHERED BALLOONS.(U)

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NEW HARDWARE FOR TETHERED BALLOONS

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Three hardware items have been produced which should be useful in tethered balloon operations. They are: a self-contained balloon valve, called a smart valve, which can be used in a hostile environment; a general-purpose tetrahedron, which simplifies balloon let-up when multiple tethers are employed; and quick-acting couplings, which speed up the launch procedure.

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NEW HARDWARE FOR TETHERED BALLOONS

1. INTRODUCTION

Launch testing of a proposed balloon-supported antenna for the Loran C/D navigation system led to the development of three devices that are applicable to tethered balloon operations, namely a smart valve, a convenient tetrahedron structure, and quick-acting couplings. This report presents a brief description of these items, and the reasons for producing them. All are now available for use at the Holloman Air Force Base launch site.

2. SMART VALVES

Motor-operated gas valves are an essential part of tethered balloons, serving to relieve internal pressure when it becomes excessive, and to deflate the balloon either at take-down, or in an emergency if the balloon should get away. In March 1977, when the Loran antenna was first tested, the practice was to actuate the valves by instrumentation placed in the rigging just below the confluence point. In addition to necessary batteries, the instrument package contained a differential-pressure switch, and a command receiver. Long wires extended up to the gas valves to actuate them, and a long tube was used to sense the balloon's internal pressure.

Such an arrangement meets the essential control and safety requirements for most situations, but it was considered unsuitable for the planned operational test of the Loran antenna because the long wires and the sensitive receiver would be in the strong electromagnetic fields surrounding the antenna. In such an environment, spurious operation of the valves could be expected, which would not be acceptable.

Essential requirements for the balloon valves are (1) the valves should open if the internal pressure exceeds a preset limit, normally 2-inches of water, and should close after the internal pressure drops below the preset level, (2) the valves must open, and be latched open, if the balloon gets away, and (3) the valves must be openable for deflation when the balloon is taken down at the end of the operation.

Providing safety by commanding the valves requires an alert and ever-present operator at the command transmitter on the ground, and it assumes the command system is operable after the emergency develops, which might not be the case if the balloon happened to be set free by a lightning stroke that destroyed the tether line and the receiver.

After studying the problem it became clear that the simplest procedure would be to replace the command system with a valve assembly that would provide the essential functions automatically, and could be shielded from the strong electromagnetic fields. This would also solve the problem of inserting an instrumentation package into the tether line, thereby simplifying the launch operation, and it would eliminate the ground transmitter. It would also get rid of the troublesome long wires extending from the command package to the valves, and a long pressure-sensing tube that followed the same path.

The new arrangement, called a smart valve, used the dish, the ring, and the drive mechanism from the old EV-13 type valve, but otherwise employed completely different parts. It included a differential-pressure switch of the type formerly used in the command package, but without the long pressure-sensing tube, and an aneroid-operated switch that would latch the valve open in case the balloon was set free. Setting for the aneroid would be above the normal balloon altitude, but below the altitude to which it would rise if it were free to float.

All circuitry is well shielded, and no diodes are used, so the valve should operate in the hostile region surrounding the Loran antenna. The new valve is a self-contained entity similar in appearance to the former valve, but does contain batteries, an aneroid-operated switch, and a differential-pressure switch. Design is such that either the aneroid-operated switch or the differential-pressure switch can be easily removed for checking or setting in the laboratory. Likewise the batteries can be readily removed for charging. Test buttons are provided which allow for a very simple checkout prior to flight. In this, the operation of the differential-pressure switch and the aneroid-operated switch are simulated, and the circuitry is so arranged that the test fails if either of these items is unplugged. Checking is done when the main cover is on and the valve is ready to be used. A successful test using the buttons checks both the functioning of the circuitry and the fact that the removable elements are plugged in properly.

Provision was made for actuating the valve when the balloon is brought down and deflated. A four-pin receptacle on the unit makes it possible to actuate the valve either by a special switch mounted on the unit, or through an electrical cable. Connections available at the four-pin plug include the circuit ground, a circuit junction that if connected to ground will cause the valve to open and stay open as long as the ground connection is held, and a circuit junction that if momentarily connected to ground will cause the valve to latch open. For most situations it would be permissible, and possibly convenient, to extend a cable down from the four-pin connector to the confluence point, and actuate the valve from there during deflation. But when strong electromagnetic fields are present, and cables cannot be tolerated, the valve can be latched open by remotely breaking a tie on a special spring-loaded switch mounted on the valve, this being done by jerking an insulated tag line.

Four of the smart valves were manufactured and turned over to AFGL for operational use, and parts for four additional ones were manufactured at Tufts for assembly at Bedford. Also, copies of the detailed drawings for all of the parts were supplied to Bedford so that a complete set of drawings, including assemblies, could be produced on Air Force paper using their drawing system. Those drawings, along with numerous photographs, constitute a complete record of the smart valve design.

Several photographs of the smart valve are included with this report. Fig. 1 shows the basic arrangement, with the removable differential pressure switch mounted on one side of the drive mechanism. A front view of the open valve is shown in Fig. 2, in this case with the test buttons exposed for preflight test. In Fig. 3 the protective cover has been removed to show the removable batteries, and the removable aneroid-operated switch. Fig. 4 shows the special switch that can be actuated by jerking the tag line, which is also displayed.

3. SPECIAL HARDWARE

When the proposed balloon-supported Loran C/D antenna arrangement was first tested at Holloman in March 1977, it was evident that the rigging was excessively cumbersome. In that exercise a total of 10 shackles and a triplate were needed at the confluence point to join the 16 flying lines to a swivel. All shackles were wrench-tightened, and safety tied using 550-pound nylon line. This part of the operation was time-consuming, and on that occasion it was made somewhat more so because a few of the flying lines had to be detached and untangled, which meant cutting the safety ties, loosening the shackles, straightening the flying lines, wrench-tightening the shackles a second time, and finally putting on new safety ties. Although the method used was adequate, it was clear that better hardware could enormously simplify and speed up the launch operation.

Work on the problem produced hardware that replaced the shackles and the triplate with hand-operated, quick-acting fixtures. The new hardware requires no wrench-tightening and no safety ties, and it is easy and fast to incorporate into the rigging. Rated strength of the fixtures is equal to the combined ultimate strength of the flying lines on the balloon used in the test. These new components should be useful in tethered balloon operations at Holloman AFB and elsewhere. Photographs of the two rigging arrangements are shown in Figs. 5 and 6.

Another hardware item specifically built for tethered balloon operations was a general-purpose tetrahedron similar to the one that had been designed for the Loran C/D antenna. It was requested because the tetrahedron had been particularly successful in eliminating the twisting troubles experienced when multiple tethers are used. The new unit was the same size as the original one, and had the same ultimate strength, 20,000 pounds, but the corner terminations were made with eye bolts to avoid the extensive machine work that was involved in making the smooth, corona-free, high-current connections required in the earlier design.

4. CONCLUSION

In planning for the operational test of the Loran antenna it was necessary to devise a different means for controlling the balloon valves than had formerly been used. This resulted in the design and production of the so-called smart valve, an item which should be generally useful in tethered balloon operations. When used, the instrumentation package is not needed for valve control, which simplifies the launch, and there is no need for a ground-based transmitter with an ever-present operator to provide safety. Two other hardware items were produced for use in tethered balloon operations, specifically the general-purpose tetrahedron and the quick-acting couplings. Both were outgrowths of the work with the balloon-supported antenna.

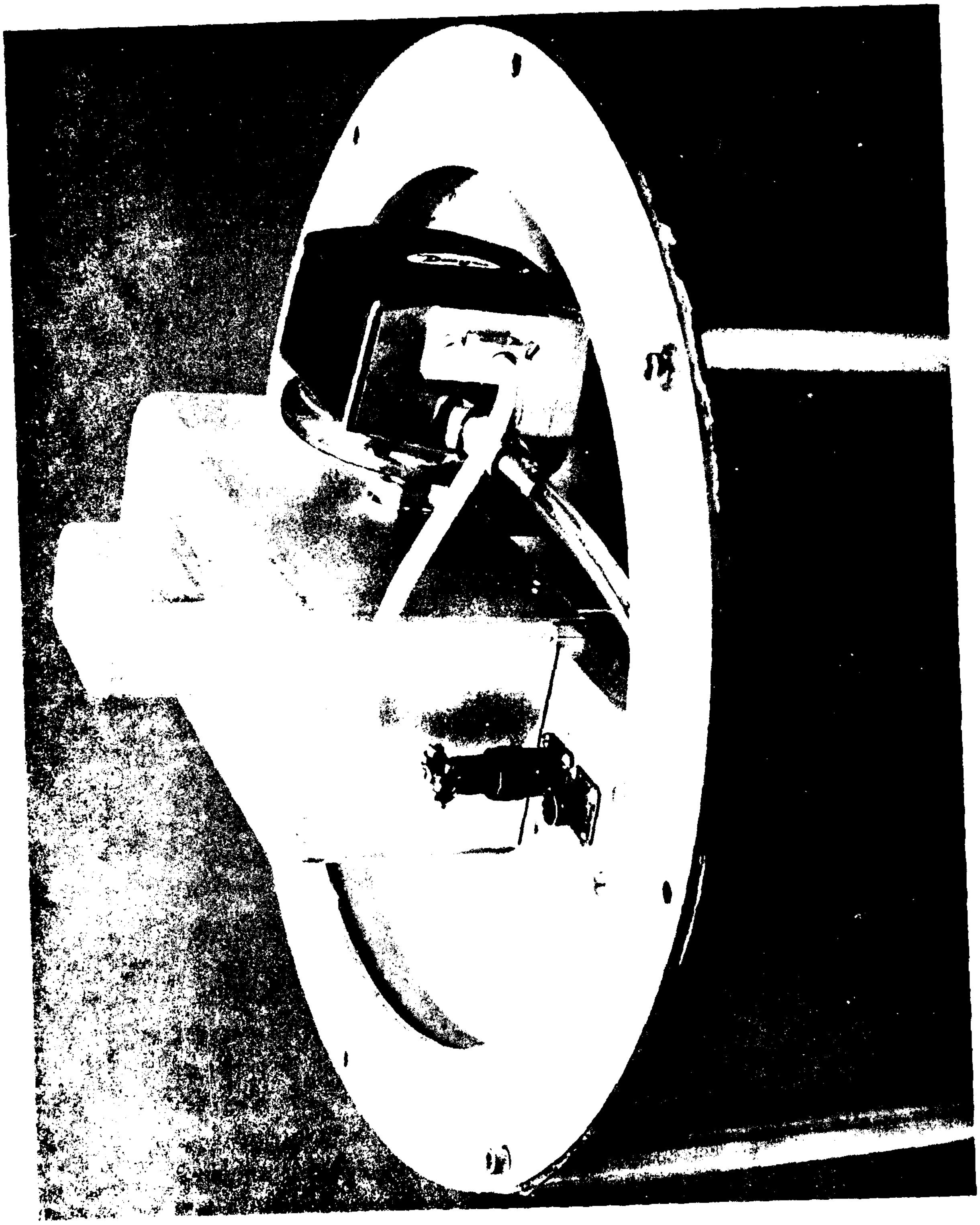

Figure 1. External View of Smart Valve Assembly with Removable Differential

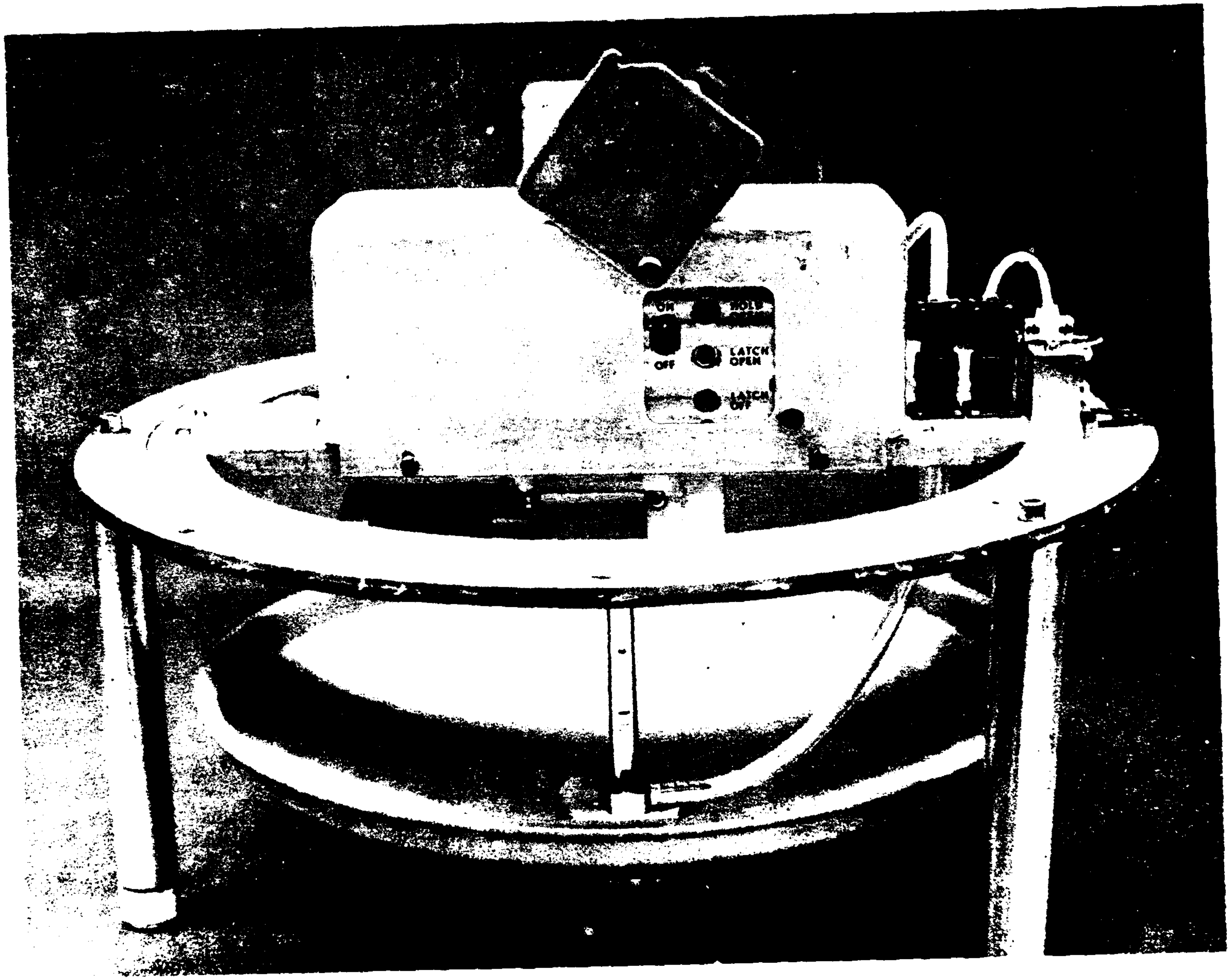

Figure 2. Smart Valve is Open, and Test Buttons are Available for Preflight Checkout

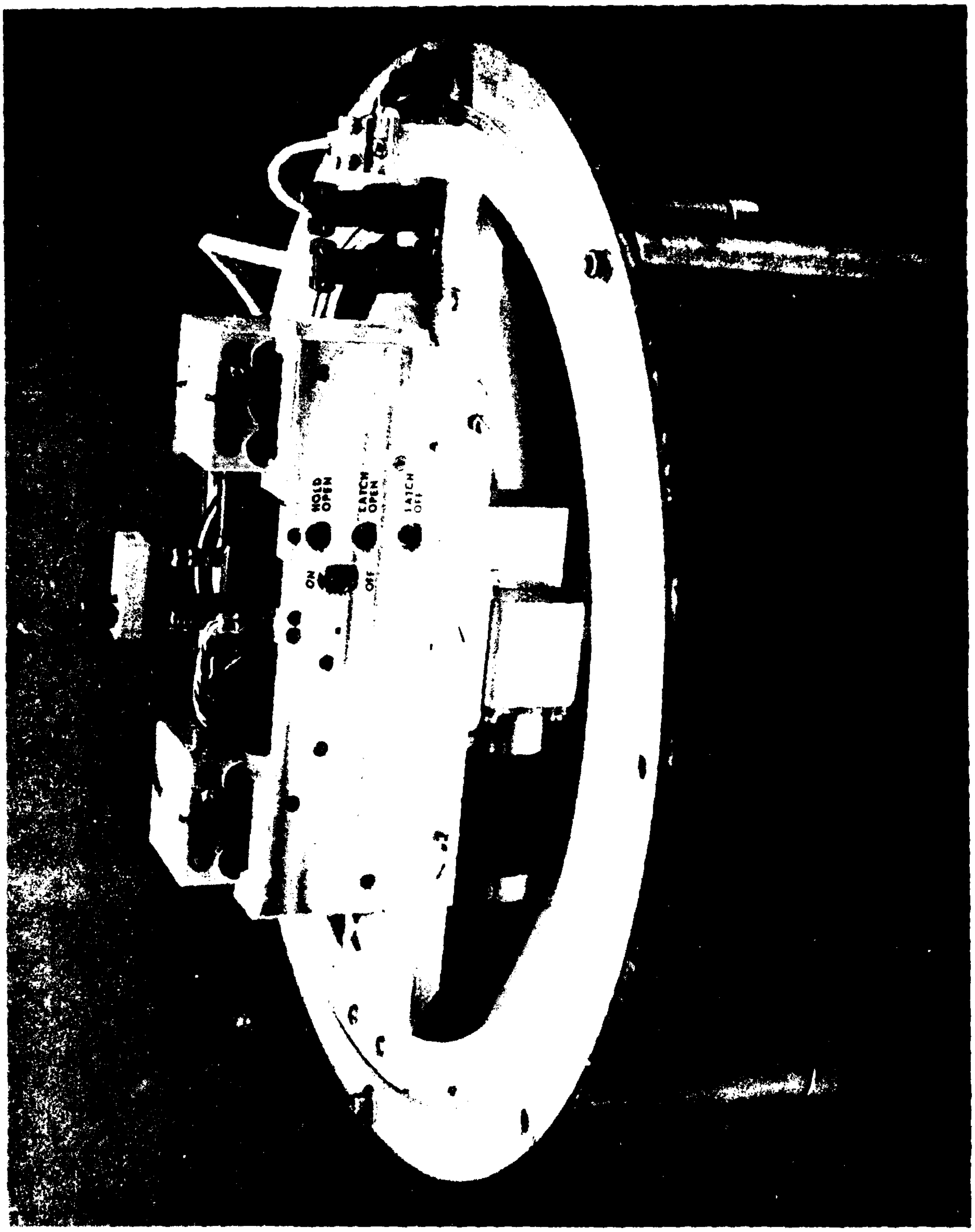

Figure 3. Valve Arrangement with Protective Cover Removed

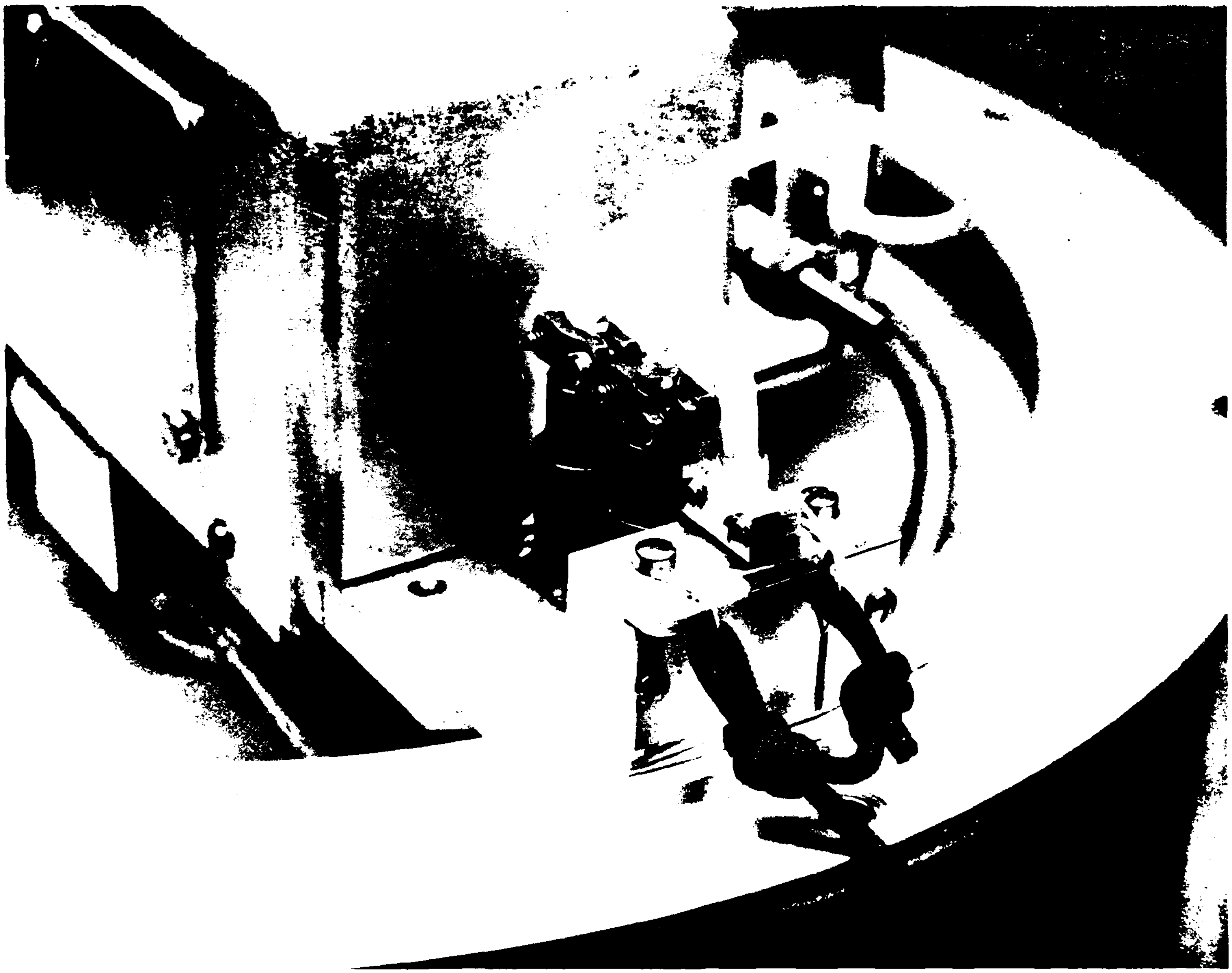

Figure 4. View Showing Tag Line and Special Switch Used to Latch Open for Deflation

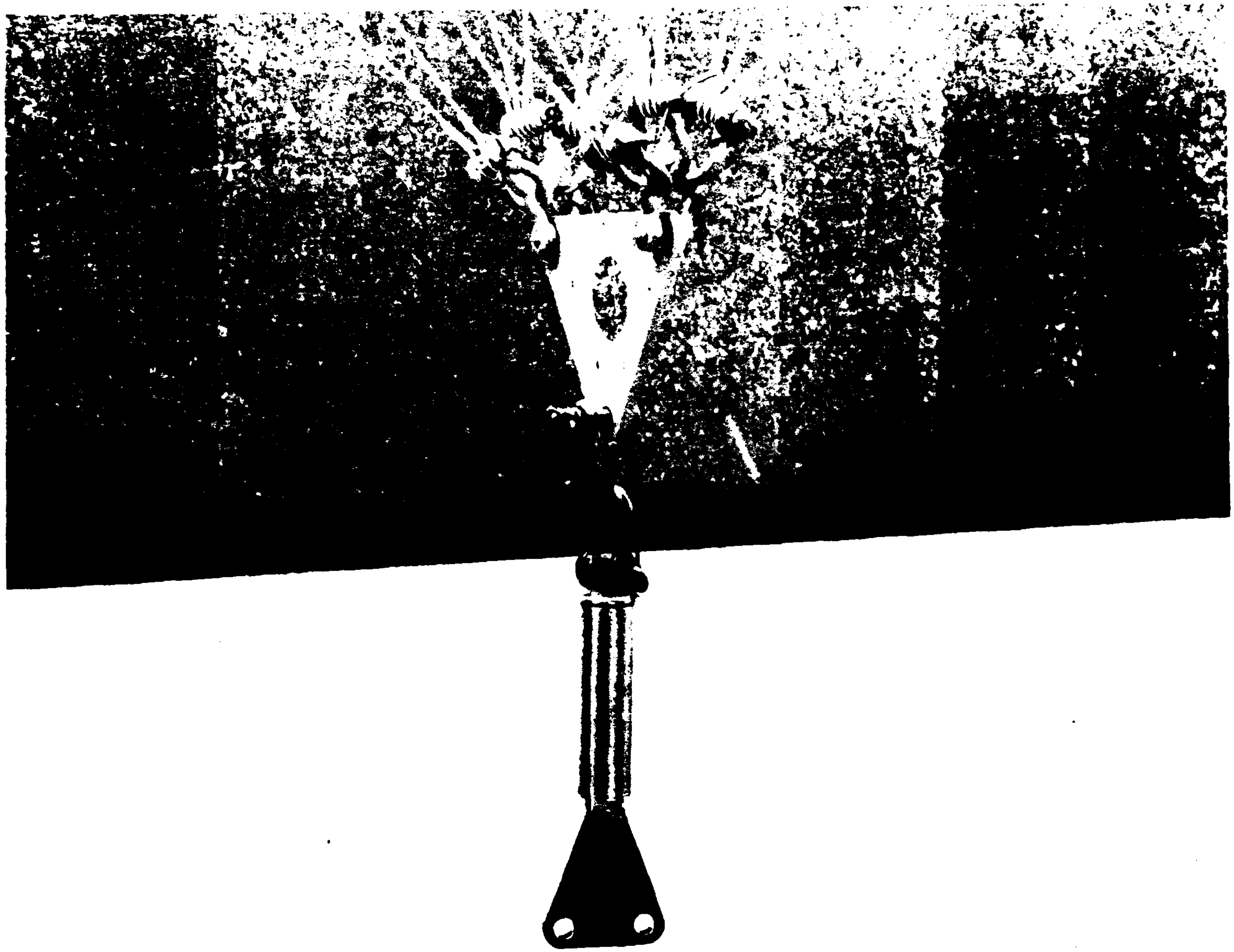

Figure 5. Shackles, All Safety Tied, and Triplate Formerly Used at Confluence Point

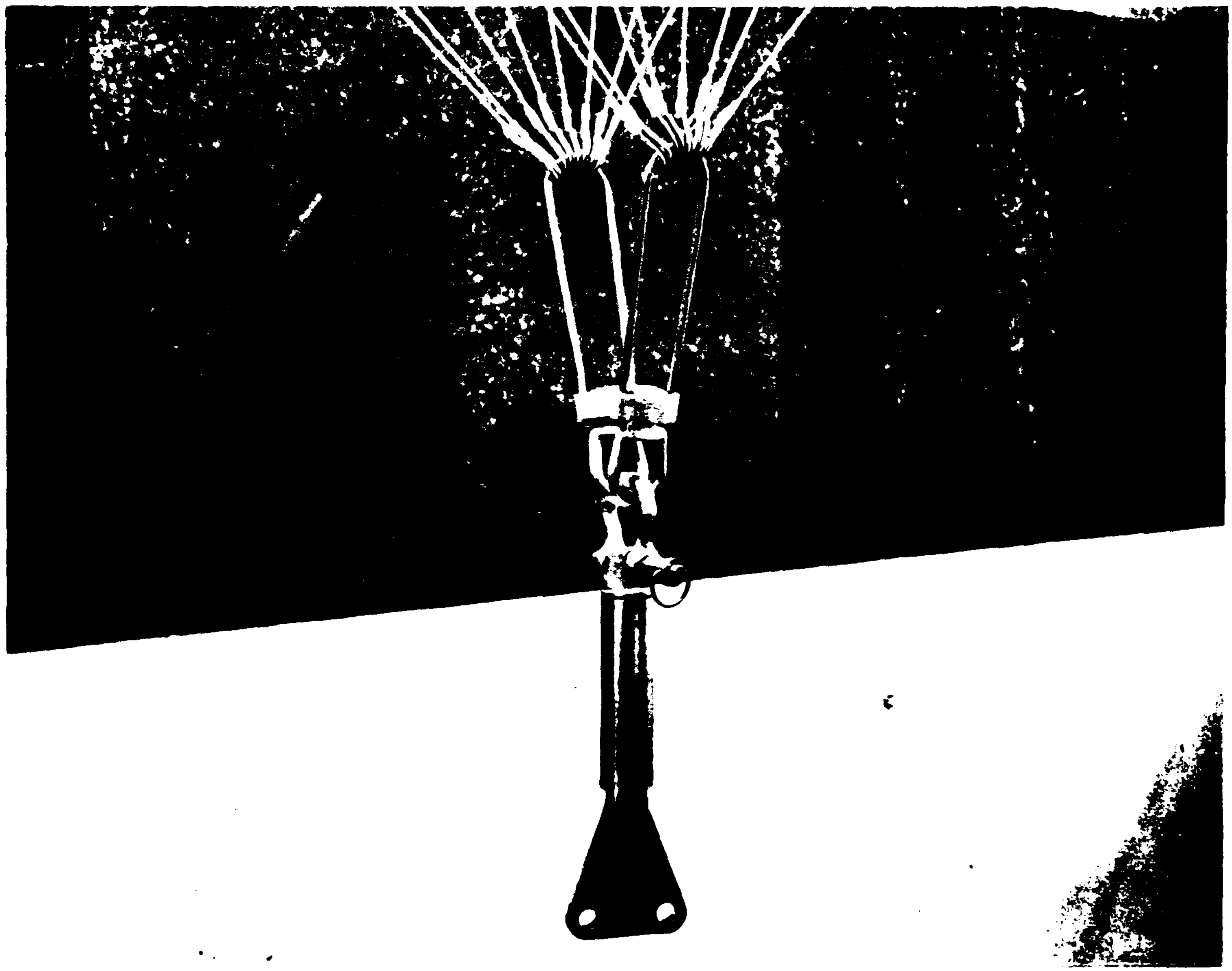

Figure 6. Quick-Connect Hardware for Use at Confluence Point